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Virtual Ideation Platform and Entrepreneurship

Introduction

Stakeholders from around New England under the leadership of Central Maine Community College (CMCC) staff are collaborating to develop the Virtual Ideation Platform (VIP). These stakeholders include faculty members, content expert, administrations and industry personnel. Funded under an NSF Advanced Technology Education grant the VIP model enables faculty members and their students across New England to conceive, design, evaluate, prototype, test and tool-up for various product concepts using the Internet. Faculty, their students along with industry partners now have access to a vibrant and evolving virtual product design and development environment.

The VIP model is a virtual product development environment that replicates Global Product Development, a high tech value-added network[1]. From a regional perspective, policymakers around New England increasingly are beginning to recognize the contribution of high tech manufacturing networks and their impact on local and regional economies. A recent Deloitte report outlines how high tech businesses are highly integrated, encouraging economic development and global competitiveness[2]. The authors point out that for advanced manufacturing, a skilled workforce is absolutely imperative. The impact of information technology networks has been well researched and accounts for significant improvement in product quality, time to market, and increased market share through shared knowledge[3]. Still others point out that, "As markets become increasingly demanding for customized and low cost goods, enterprises must seek new organizational paradigms to keep competitive. In the last years information technologies have opened the door for the establishment of borderless profitable associations"[4]. Finally, the potential for entrepreneurial endeavors is substantial [5].The implications are critical as the United States struggles to regain lost market share and capture new markets. The VIP project has been developed to emulate this value-added network. Therefore, the objectives of the VIP project, based on promising practices and lessons learned are to

- design and development via the Internet using the product evolution framework
- design for the environment via product life cycle analysis coupled with life cycle costing
- foster product commercialization and awareness of intellectual property rights
- select projects that engage underrepresented students in technology and engineering

These objectives have driven the pedagogical and cultural mission of the VIP by providing students with skills beyond their specific disciplines, enabling them to easily transition and work in a virtual environment. As the VIP team matures, faculty members have defined and refined student-learning objectives for their individual disciplines as well as those needed for virtual product development. From a cultural standpoint students across the VIP are encouraged to appreciate the respective skill sets and limitations each brings to the development process. Students across the VIP now have a systems perspective as well as a better sense of how important their work is to the overall success of a project. These students have additional skills and learning opportunities that are unavailable in a traditional lecture - lab environment.

There are strong economic imperatives that fostering entrepreneurship be an important outcome of the overall VIP effort. The most obvious and pressing is the "Great Recession". Economic

indicators are ambiguous and are sometimes contradictory lending strong arguments on either side that indicate the strength of the United States economy. Regardless, the level of continued unemployment is undeniable and is the most crucial for educators who are trying to provide as many employment options for their students as possible. Therefore VIP stakeholders recognize the employment and economic development benefits of entrepreneurship as well as intrapreneurship[6].

Given the recent successes of VIP students starting their own companies the VIP staff is now actively encouraging students to identify and seek not only entrepreneurial opportunities but also intrapreneurship. Intrapreneurship can be defined as entrepreneurship within existing organizations. There are other names given to this dynamic, such as 'corporate entrepreneurship' and 'corporate venturing' however, throughout this paper we will use the term entrepreneurship to refer to both concepts[7]. A key element needed to support entrepreneurship is the creation of interdisciplinary teams. This has been accomplished by coordinating schedules, curricula and programs of study across the VIP network and includes a number of colleges that coordinate their efforts to complete projects.

VIP Institutions Core Competencies and Related Activities

To fully appreciate the regional demographics of the VIP, a list of campuses along with their core competencies and responsibilities is listed below.

Institutions	Affiliation	Core Competencies	Related Activities
Central Maine Community College Auburn, Maine	Lead Institution	Precision Machining Program is NIMS certified, Sponsors RapidTech workshops as well as diversity and teamwork training	Polycom hub Curriculum Development Oversight of projects Component and tooling fabrication
The Precision Machining Technology Program (PMT) is National Institute for Metalworking Standards (NIMS) certified. The PMT has four full time faculty, an extensive machine tool laboratory which includes all traditional and CNC machining equipment, and CNC wire and plunger EDM equipment. Restructured entire machine tool curriculum to better align with the VIP model.			
Keene State College Keene, New Hampshire	Partner	Sustainable Product Design & Innovation (SPDI) Modeling & Industrial Design Rapid Prototyping Pathway for community college students	Polycom link Curriculum development and integration of curriculum into Management Program Development of product life cycle costing course & entrepreneurship capstone
The Sustainable Product Design and Innovation (SPDI) program of study encourages students to design with the environment in mind. The uniqueness of SPDI allows out of state students from New England to qualify for New Hampshire in-state tuition rates. The SPDI program is fully integrated with the Management Program enabling SPDI students to obtain minors in Management.			

Springfield Technical Community College Springfield, Massachusetts	Partner	Documentation Product Lifecycle Management Quality Standards First Article Inspection	Polycom link Oldest community college business incubator in the country Documentation review
The oldest Community College industry incubator in the country. Part of a national historic munitions complex, serves large population of underrepresented students.			
Saddleback College Mission Viejo, California	ATE - Partner	Rapid Prototyping (RP) 3D laser scanning & related RP technologies	Polycom link Supports RP workshops and overall RP support
Provides expertise on additive technologies and digital manufacturing. Provides access to RP equipment not normally available to community colleges.			
Connecticut College of Technology Hartford, Connecticut	ATE - Mentor	Advanced Manufacturing Underrepresented Student Recruitment Student Expositions	Polycom link Dissemination Curriculum review Project assessment
Consists of all 12 Connecticut community college with a common numbering system. Community College courses in Engineering Science articulate to all state universities. The staff at the Regional Center for Next Generation Manufacturing is providing coaching and support for the VIP-RC.			
Manufacturers Association of Maine	Industry Partner	Oversees economic development and support of manufacturing firms	Project and Curriculum Review, Member of National Advisory Board
Professional manufacturing industry organization for the entire state of Maine. Provides direct conduit to all manufacturing firms across the state.			
New England Board of Higher Education Boston, Massachusetts	ATE – Partner	Curriculum review Project Assessment Dissemination	New England wide curriculum review and dissemination
Oversees reciprocity program among New England colleges. Recipient of numerous ATE project grants in Problem Based Learning and optics. NEBHE staff also helps support regional meetings, being central to all VIP institutions as well as curriculum dissemination.			

Evolution of the VIP

Under the leadership of stakeholders from CMCC the potential of the VIP model was finally realized. The CMCC stakeholders undertook the necessary steps and financial risk to begin the VIP project. A number of planning meetings were held by the CMCC staff to identify the necessary faculty to create the needed critical mass from core disciplines such as design, machine tool technology, production planning, metrology, management and engineering analysis. These disciplines also represent core competencies needed to build a virtual incubator to enable faculty and their students to undertake complex projects. There were sufficient course offerings on each campus to provide students with the necessary environment to develop their own product concepts and in the process spurring innovation[8]. Other programs within the VIP also provided

innovative course delivery as well as an environmental theme to the VIP.

From a historical perspective a novel product design course sequence was developed under an earlier NSF grant to Keene State College beginning 1995. The grant work entitled, "The Evolving Role of Technologists" involved the creation of a four course sequence in product design and development. This new course sequence allows students to slowly and progressively integrating their knowledge from other disciplines. An added benefit of this model is that students are better able to appreciate the relevance and importance of their other courses such as mathematics, science, and the arts. This curriculum structure supports a student centered rather than a teacher centered model for student learning. It also provides the time necessary to work on complex and time consuming projects since the work can progress throughout the entire Product Design I through IV sequence. Thematically, due to its institutional partners, the VIP has sustainable product design at its core. This has been accomplished through providing an early design framework based on Okala and similar design tools that encourage the prudent use of raw materials and the creation of energy savings devices and services.

Current VIP stakeholders recognize that there are constraints on the types of projects that can be undertaken. Therefore new partners are being recruited to overcome limitations in expertise, curriculum and laboratory facilities allowing more complex projects to be undertaken. Collectively the VIP model is evolving into a robust virtual learning community emulating global product development[9]. These additional competencies will increase the entrepreneurial potential for all students across the VIP.

Limitations of Existing Entrepreneurial Models

The literature is rife with courses, minor and major degree programs as well as college foundations that support student entrepreneurship. Entrepreneurship is the fastest growing subject in today's undergraduate education; it has quadrupled from over 104 in 1975 to more than 500 in 2006[10]. Regardless, many colleges explore entrepreneurship at "arms length" and offer courses on "how to" become an entrepreneur or explores the dynamics of entrepreneurship. This seems to be an historical remnant where entrepreneurship was treated as an add-on to existing business programs [9]. There is limited availability of programs devoted to bringing students concepts through the entire development process and into the marketplace particularity for manufactured products. To be able to bring sophisticated products to full commercialization requires access to extensive laboratory facilities as well as technical and business expertise. This can only be done with access to extensive laboratory facilities, without those facilities students cannot physically or conceptually work through all the product development issues. This is especially true as it relates to tooling and building capacity from pilot production to full production. In the field of entrepreneurship many educators agree and the research supports the hands-on immersion model as the most intellectual stimulating, holds the greatest potential for innovation[11].

One common entrepreneurial model has students undertake industry projects. This is appropriate since it allows students to take on some aspects of product and service development. However the problem with this model is fourfold. First, the student lacks ownership and secondly there may be limited employment opportunities after graduation. An additional problem is that the

resulting product or service may not necessarily be made in the United States. Finally students may or may not own their own intellectual property; it is generally signed over to the company sponsoring the project. Regardless industry-based projects are still a worthwhile experience since it gets students involved with real-world problems. One notable exception is the Bring Your Own Business (BYOBiz) program offered at Champlain College in Vermont. Again, this model is based largely on service learning with demonstration efforts with some noticeable and laudable results. The program is designed to take a student's concept and development it into a full business.

Another more subtle issue is related to economic impact. The more traditional models for entrepreneurial education too often lead to "replicative entrepreneurs" that simply sell goods and services that are already commonly available. What is critical for economic development is the development of "innovative entrepreneurs"[12]. Innovative entrepreneurship can only be achieved within an arena where students can conceptualize new products and services while learning the methodology of product and service development in its entirety.

The VIP Model

In contrast to the previous models mentioned the VIP model allows student teams to be fully vested in their own projects. The most exciting aspect of the VIP model for student entrepreneurship is that they have the potential to take products to full commercialization. The VIP's educational framework encompasses the requisite core concepts to achieve commercialization. Beginning with conceptualization, these competencies include quality function deployment; assessing market demand; developing product specifications; building and testing prototypes; performing cost analysis; designing and building tooling; culminating in the creation of a business plan. The VIP's framework allows students to evaluate concepts within a business context while working towards full commercialization. This is accomplished by enabling students to overcoming three fundamental hurdles in new product development: concept analysis and refinement, assessing market demand, and capacity building or tooling. Students have access to knowledgeable faculty who are well versed in all phases of product and business development. Supporting VIP faculty is a cohort of industrial and business experts throughout the VIP network. In other words, if faculty members are unable to answer a question, the VIP can find an expert who does and who is generally more than willing to share their expertise with students. Due to the numerous industrial contacts throughout the VIP, any production capacity issues, including equipment size, can be overcome since industry opens its doors to help with pilot production. Regardless, to optimize the VIP model as it relates to student-based projects and entrepreneurship, there remain some issues that need to be addressed.

The VIP Entrepreneurship Ecosystem

Students in the VIP were quick to capitalize on the virtual product development process allowing them to commercialize products and establish companies. These small companies, if successful, have the potential of helping support local, and in some cases regional, economic development. As Sidhu, Tenderich and Broderick point out, "Building ecosystems is critical to nurturing entrepreneurship and innovation within the academic setting and the greater community"[13]. Therefore the issue for VIP faculty is to overcome existing constraints in logistics and

pedagogical practices. They need to work collectively to better align curriculum, course sequence, capstone courses and entire programs to help support student entrepreneurs. The VIP model has already placed additional pressures on faculty members but they recognize the benefits to the students and potential economic development. Regardless the VIP model has some important characteristics that hopefully will help guide the development of similar programs.

To support student entrepreneurship and realize the full potential of the VIP requires work in key areas. These areas include student recruitment, in particular underrepresented students. Additionally, limitations imposed by accrediting agencies as well as national standards organizations have a direct impact on the "flexibility" of curriculum development. Finally to ensure long term sustainability of the VIP, financial support must be provided.

The initial hurdle is to create an environment that helps students develop innovative concepts. It is important to acknowledge and nurture each student's innate creativity. How should students be supported within the framework of individual programs across the VIP? One immediate challenge is the early identification and nurturing of potential student entrepreneurs. This is especially true when trying to encourage underrepresented students into technology and engineering programs. However, there is research to support that idea that entrepreneurship holds great potential to engage underrepresented students[14]. Linkages and articulation agreements with regional comprehensive and technical high schools is an important first step. In addition, students that have attended high school courses developed by the National Foundation for Teaching Entrepreneurship and Project Lead the Way hold great promise. There is a need at the collegiate level, to help promote and demonstrate the VIP model to incoming students at student orientation, and the promise it holds for their future as an another career option. Student-based ideas rely heavily on long term interests, often involving hobbies and/or specific work experience. These efforts must be nurtured wherever and whenever possible at all grade levels [15]. Closely coupled with developing students' interest is the need to modify courses, to identify, capture and foster entrepreneurial traits within individual courses. The VIP team constantly struggles with integrating projects into their curriculum while still meeting accreditation and national academic standards.

Perhaps the most challenging of these is the CMCC objective to have their students meet the National Institute for Metalworking Skills (NIMS) standards. Performance based, this is a highly prescriptive and rigorous national metalworking standard. Prints are provided for students who must interpret and fabricate the part. These parts are sent to NIMS judges for acceptance or rejection. Students who meet this multilevel certification have skill sets that can be recognized anywhere in the United States. This highly structured certification leaves limited room for students to work on VIP projects. Unfortunately, existing NIMS prints mean little to students and there is no functionality tied to the part. These prints are basically "sterile," devoid of any functionality or ability to be modified based on product requirements. Therefore, the VIP is taking a leadership role in attempting to encourage the NIMS staff to consider looking at appropriate VIP projects as an alternate or complementary avenue for certification. The VIP is attempting to address this issue by getting national accrediting agencies to accept student projects as valid performance based standards.

Another curriculum issue is the need to identify and codify non-traditional learning objectives such as the ability to coordinate work virtually and identify new cross-curricular learning outcomes. Finally, the proper alignment of content and courses to optimize the product development process is an ongoing process. The VIP team, on a semi-annual basis, conducts course and program reviews as an integral part of its interdisciplinary model. Trying to modify curriculum and to make room to support existing curriculum is challenging. Given accreditation requirements, the need to have students achieve existing student learning objectives while continuing to blending VIP related learning objectives requires considerable time and attention from faculty. Therefore, faculty must be willing to review student learning objectives and determine which ones are outdated, redundant, and which ones can be substituted with VIP related objectives. Regardless, faculty members are committed to overcoming these limitations and trying to fulfill student learning objectives within a virtual project development environment. Another challenge is the need to document and evaluate new student learning objectives, if faculty members are to ascertain the full educational potential of the VIP model.

Project Evolution and Selection

The four main sources of projects are curriculum development projects, industry-based projects, student-based projects and projects from individual inventors. The solicitation of projects for the VIP was organic without any real attempt to identify specific project areas. The VIP from its inception had a significant number of projects already underway at its individual campuses. However, the selection of existing projects to be worked on collectively by the VIP was highly structured. A project matrix selection sheet was developed to obtain critical information from the concept originator allowing uniform assessment by the VIP team. This matrix allows the VIP team to determine if the project enables faculty to meet specific student learning outcomes and their potential to engage underrepresented groups. The matrix also allows the faculty to access overall technical complexity, required recourse allocation and potential for commercialization. Priority is given to projects that allow faculty to meet specific student learning objectives and actively engage underrepresented students. The VIP team has agreed to explore how to engage students' interest and actively begin to align, where possible, curriculum around student-based projects.

Conclusion

The VIP holds the potential of providing a robust environment for nurturing fledgling entrepreneurs and intrapreneurs. The inherently interdisciplinary structure of the VIP model overcomes one of the more pressing issues needed to create an entrepreneurial environment. The VIP interdisciplinary core represents all of the key attributes needed for product commercialization. Given the technology core of the VIP program, it avoids, "mimicking the teaching techniques and material found in business schools" [14]. The Product Design I through IV sequence within the Sustainable Product Design and Innovation program is an ideal course sequence that allows students to progressively develop and nurture a product concept without the strict academic and time constraints. Unfortunately the community colleges are much more constrained in terms of courses, curriculum and time. However, teams are formed to solve problems which hopefully could lead to students from the various VIP campuses to coordinate their efforts and build their own businesses upon graduation.

Intellectual property issues need to be clarified to be certain that student rights are protected. This becomes complicated given the varying needs of project done for companies, the individual colleges and those projects that are strictly initiated by students. Providing start-up money for students is always problematic. Generally start-ups use personal or family resources rather that venture capital.

Regardless, the full potential of the VIP to create a robust entrepreneur ecosystem can only be realized if accreditation/standards, faculty and curriculum constraints are overcome and resolved. Toward this end a clear definition of student entrepreneurship is needed; a definition that differentiates it from other forms of pedagogy and entrepreneurial education. In the case of the VIP construct, we propose that student entrepreneurship is the full development of a student initiated product and or service during their undergraduate term as well as a complete business plan to help ensure a successful business launch. Full implementation involves undergoing rigorous development: conceptualization, market assessment, marketing, prototyping, testing, pilot production and early capacity building, tooling, and sales. The use of the life-cycle framework provides the necessary "road-map" helping students delineate the various aspects of design, testing, tooling and commercialization. The fledgling success of the VIP offers up many questions and areas for research. The most pressing research question is: What is the maximum level of "innovative entrepreneurship" that can be achieved with the VIP model?

Jerome Katz makes a prophetic and accurate observation by pointing out that, "One future uncertainty is the form or forms of entrepreneurship education that dominate in the new century. The next new paradigm could come from anywhere on the globe, emerging from the new infusions of culture, business settings and institutional influences. For the 20th century's history of entrepreneurship education, the world turned to America for inspiration. For the 21st century version, the world could turn anywhere"[15]. The VIP model replicates global product development holds the potential to help faculty fully unleashing our students' innate imagination and resourcefulness. The VIP provides a virtual incubator, giving students access to the knowledge base and resources needed to establish companies that have the potential to compete locally, regionally and globally.

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